

Air embolism during arthrography for developmental dysplasia of the hip

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Abstract

Arthrography is useful method to evaluate obstruct factors and the congruity of the femoral head for developmental dysplasia of the hip. We usually use an air injection to ascertain whether the needle is accurately insert intraarticularly, because leakage of the contrast medium may make it difficult to identify intraarticular structure in the hip joint. We report the experience the case that suspected air embolism by air injection in the arthrogram. An air injection for arthrography must be avoided the case of infants. To confirm that a needle is correctly inserted intraarticularly, it is preferable to inject saline. Alternatively, it may be suitable to use sonography for confirming the position of the needle for arthrography.

Introduction

During the treatment of developmental dysplasia of the hip (DDH) by closed reduction under general anesthesia, arthrography is used to evaluate obstructions such as the labrum, ligamentum teres, and pulvinar, and the congruity of the femoral head. The utility of arthrography has been previously reported.^{1,2} However, an air embolism may occur as a complication of arthrography. Air embolisms are usually caused by various diagnostic and therapeutic air injections, certain surgical procedures, obstetrical procedures, and accidental entrance of air into intravenous catheters.^{3,4}

We report the case of an 8-month-old patient with DDH, in whom an air embolism was suspected during arthrography.

Case Report

The patient was an 8-month-old female

infant with left DDH. She had been diagnosed with dislocation of the left hip at another hospital at the age of 3 months, and she was treated with a Pavlik harness for 4 weeks. However, her left hip was not reduced, and she was admitted to our institution at the age of 8 months. The anteroposterior radiograph showed that the left femoral head was completely dislocated and had shifted to the lateral and proximal side (Figure 1). She did not have the abnormality at the time of birth; in addition, no past illness, allergy, or family history of DDH were noted. At our institution, she underwent closed reduction under general anesthesia. Her hip joint was reduced; however, it was unstable, and the femoral head was easily dislocated when we decreased the hip abduction angle down to 60°.

Subsequently, arthrography was performed to verify the reduction and to analyze the obstructive factors and afferent nature of the femoral head. First, the legs were maintained in the *frog-leg* position, and then, a 23-gauge Cathelin needle was inserted in the central part of the femoral proximal epiphyseal line using the anterior approach. After confirming that blood was not aspirated, 1 mL of air was injected to confirm that the Cathelin needle was accurately sited in the joint; subsequently, we injected 1 mL of the contrast medium.

Two minutes after air injection, the end-tidal carbon dioxide (ETCO₂) concentration decreased suddenly from 37 mmHg to 19 mmHg, and the blood oxygen concentration decreased from 99% to 97% (Figure 2). The anesthesiologist noticed the change, and he increased oxygenation from 33% oxygen to 100% under observation. The blood oxygen concentration and ETCO₂ concentration gradually improved and returned to normal values after 2 min and 12 min, respectively. Other vital signs such as blood pressure and pulse rate remained unchanged. An arthrogram showed good reduction of the femoral head. Plaster cast fixation was performed at an abduction angle of approximately 70°. After the operation, she was placed in a plaster cast, abduction brace, and Pavlik harness, for 4 weeks each. At the latest examination performed at the age of 4 years, the patient had not experienced any recurrence of dislocation.

Discussion and Conclusions

When performing arthrography to evaluate DDH, before injection of the contrast medium, an air injection is occasionally used to ascertain whether the needle is accurately inserted intraarticularly. Leakage of the contrast medium may make it difficult to identify intraarticular structures in the hip joint (Figure 3A and B).

Air embolism during arthrography is rare,

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but it is recognized as a life-threatening complication that warrants attention. The pathophysiology of air embolism involves obstruction of the pulmonary arterial outflow tract by air bubbles.³ Air may be forced into the vein by positive pressure, or may be drawn in by negative pressure in the joint.⁴ The initial sign of air embolism is a sudden change in respiratory parameters, and various cardiopulmonary symptoms and signs are observed.⁵ In our case, after air injection, a sudden decrease in ETCO₂ concentration (from 37 mmHg to 19 mmHg), and a slight decrease in blood oxygen concentration (from 99 mmHg to 97 mmHg) occurred. No changes in heart rate and blood pressure were observed. The anesthesiologist considered the possibility of an air embolism because these changes occurred soon after air injection and recovered after O₂ administration. Similarly, a few studies have reported that air embolism was diagnosed by decrease in ETCO₂ concentration and decrease in blood oxygen during hip arthrography of children.⁶ Keidan *et al.*⁶ reported a case of air embolism during arthrography in an 18-month-old male infant with DDH. Even in their case, a sudden decrease in ETCO₂ concentration and slight decrease in blood oxygen concentration were observed. They reported that after normal ventilation was achieved, the decrease in ETCO₂ concentration was related closely to the pulmonary blood flow. Furthermore, they reported that when pulmonary blood flow is obstructed by an embolus, smaller quantities of blood enter the pulmonary capillaries, which is reflected by a decrease in ETCO₂ concentra-

tion. Although ETCO_2 concentration is a non-specific monitoring method, it indicates an increase in dead space. During the procedure, ETCO_2 monitoring is critically important, because it can indicate the occurrence of air embolism.

Most cases of arthrography complicated by air embolism have been reported in children.⁷⁻¹⁰ Air embolism led to the onset of transient respiratory disorders in all these cases, except in 1 case, in which a temporary cardiac arrest occurred with approximately 2-3 mL of air.⁷

In a canine study, it was concluded that the severity of the air embolism is associated with the quantity of air injected and speed at the time of injection.³ However, in humans, particularly in infants, most cases of air embolism involve injections of less than 5 mL of air. Therefore, in infants, it is considered that air embolism can occur with a small amount of air that is rapidly injected.⁶⁻¹⁰

In this case, the blood oxygen concentration and ETCO_2 concentration gradually improved and returned to normal after 2 min and 12 min, respectively. However, a patient with suspected air embolism should be placed in the left lateral head down position so that air in the right ventricle moves away from the pulmonary arterial outflow tract to the apex.³ Other therapies for air embolism are oxygen administration, cardiopulmonary resuscitation as needed, and aspiration of air from the heart if feasible.

Several techniques have been used to confirm accurate intraarticular needle insertion. Yun *et al.*¹¹ reported the suction-bubble technique, in which the movement of air bubbles can be visualized in the attached tubing. Straw *et al.*¹² reported a method based on adduction signs. According to their method, saline is injected into the hip with the patient in the frog-leg position: if the needle is correctly placed, then, when the joint is distended, the knee will rise (adduct) from the operating table. The alternative use of carbon dioxide (CO_2) and oxygen (O_2), instead of air, has also been suggested, because these gases are absorbed faster by the blood and are therefore considered safer than air.⁷ However, there are a few reports of embolism caused by CO_2 ¹³ and O_2 .¹⁴ Therefore, the safety of CO_2 and O_2 injections is not certain.

After our experience with this case, we began to inject saline for confirmation of the needle position before injection of the contrast media. If the needle is positioned correctly in the joint, the water flows freely in the joint.² As an alternative method, ultrasonography has recently been proposed for guiding aspiration of the hip in children.¹⁵ Ultrasonography has the added advantage of avoiding radiation exposure. It appears as an accurate method to determine whether a needle is correctly inserted intraarticularly before injection of the con-

trast media.

Arthrography is advantageous since it permits a functional study and can confirm congruity of the femoral head immediately after reduction. We believe that arthrography is necessary for the evaluation of closed reduction of DDH. However, our case and other reports suggest that in the case of infants, an air injection for arthrography must be avoided. To confirm that a needle is correctly inserted intraarticularly, it is preferable to inject saline. Alternatively, it may be suitable to use sonography for confirming the position of the needle for arthrography.



Figure 1. Anteroposterior hip radiograph of an 8-month-old female patient with left developmental dysplasia of the hip. The left hip was not reduced by the Pavlik harness.

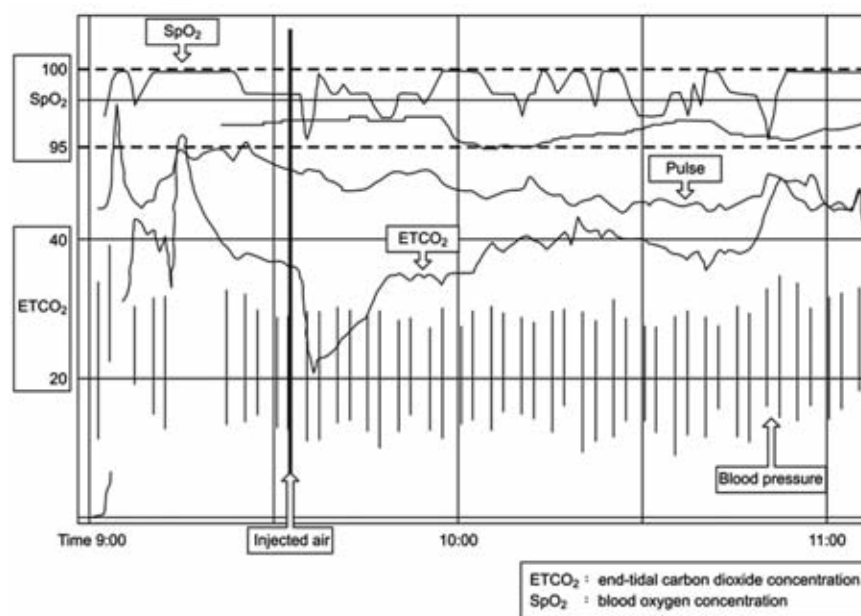


Figure 2. Automated data recording shows that after air injection, the end-tidal carbon dioxide concentration suddenly decreased from 37 mmHg to 19 mmHg, and blood oxygen concentration decreased from 99% to 97%.

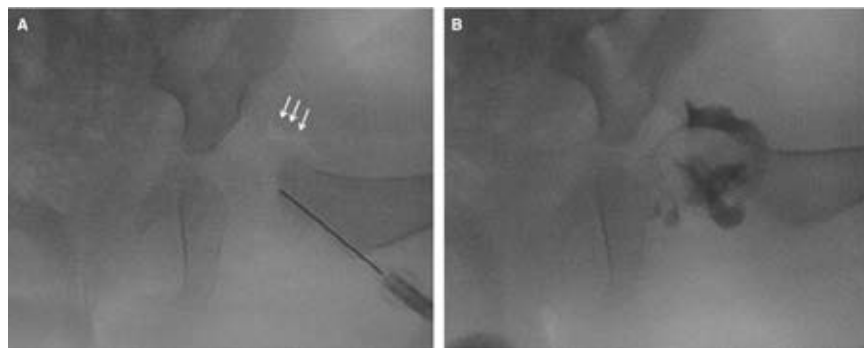


Figure 3. A) Air injection during arthrography. One mL of air is injected to confirm accurate intraarticular needle placement. The arthrogram shows that the needle has been inserted intraarticularly in the upper part of the femoral head. B) Arthrography with contrast media. Good reduction of the femoral head is seen, and pooling of the contrast media is not seen between the acetabulum and femoral head.

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